

Panel 1

Last time:loops $\begin{cases} \text{for} \\ \text{while} \end{cases}$ user input $\begin{cases} \text{Console.read Int()} \\ \text{Console.read Double()} \end{cases}$

Examples

HW: find if # is prime
due Friday

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Panel 2

Example. Find $\lim_{x \rightarrow 0} \frac{\sin(x)}{x} = \underline{1}$

Means: x gets closer and closer to 0, check $f(x)$
for a pattern!

| x | $f(x)$ |
|-------|--------|
| 0.1 | . |
| 0.01 | . |
| 0.001 | . |
| ... | ... |

① figure out $f(0.00001) \approx$

try $\lim_{x \rightarrow 0} \frac{\sin(100000x)}{x} \approx \underline{\underline{0}}$

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Panel 3

$$\lim_{x \rightarrow 0} \frac{\sin(1000000\pi x)}{x} = 1000000\pi \neq 0$$

```
public class Loopy
{
    public static void main(String args[])
    {
        for (double x = 0.1; x > 10E-10 ; x /= 10.0)
        {
            double y = Math.sin(100000*Math.PI*x)/x;
            System.out.println("f(x) = " + y);
        }
    }
}
```

works, but checks only
positive x

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Panel 4

Need:

| x | f(x) |
|--------|------|
| 0.1 | |
| 0.01 | |
| 0.001 | |
| ⋮ | |
| -0.1 | |
| -0.01 | |
| -0.001 | |
| ⋮ | |

```
public class Loopy
{
    public static void main(String args[])
    {
        for (double x = 0.1; x > 10E-10 ; x /= 10.0)
        {
            double y = Math.sin(100000*Math.PI*x)/x;
            System.out.println("f(" + x + ") = " + y);
        }
        for (double x = -0.1; x < -10E-10 ; x /= 10.0)
        {
            double y = Math.sin(100000*Math.PI*x)/x;
            System.out.println("f(" + x + ") = " + y);
        }
    }
}
```

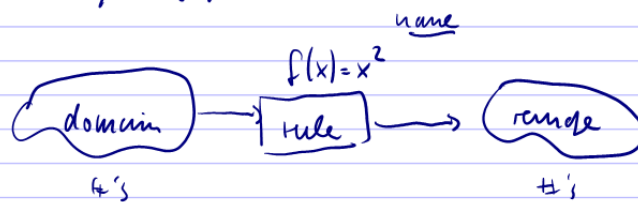
What if I want to
use a different function?

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Panel 5

Want to define a new function:

$$y = f(x) = x^2$$



In Java: return type Name (domain)
 type ↓ ↓
type

5

Panel 6

Methods ← think "function $f(x)$ "

A method² is a named segment of code that performs a small, well-defined task. It has a header that specifies how to exchange information with other methods and a body that defines what it is doing. Methods can call other methods, or in turn be called by other methods. Methods can have input parameters defined in the header to adjust their behavior and they can return a single value to the entity calling them.

Methods are defined inside the body of a class. They have the following syntax:

```
[ public static ] returnType methodName (parameterList)
/* method body */
```

where

- public static are keywords that at this stage must be present³
- returnType is a known data type or the special keyword void for no return type
- methodName is a valid Java name
- parameterList is a comma-separated list of typed input parameters, or empty

Ex: Define $f(x) = x^2$

```
public static double f(double x)
{
    return x * x;
}
```

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Panel 7

```

public class Loopy
{
    public static double f(double x)
    {
        return x*x  $\cos(x) - 1 / x \cot(x)$ 
    }

    public static void main(String args[])
    {
        for (double x = 0.1; x > 10E-10 ; x /= 10.0)
        {
            double y = f(x);
            System.out.println("f(" + x + ") = " + y);
        }
        for (double x = -0.1; x < -10E-10 ; x /= 10.0)
        {
            double y = f(x);
            System.out.println("f(" + x + ") = " + y);
        }
    }
}

```

find $\lim_{x \rightarrow 0} \frac{\cos(x) - 1}{x \cdot \cot(x)} =$

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Panel 8

$$(\text{Math.cos}(x)-1) / (x/\text{Math.tan}(x))$$

$$\frac{\cos(x)-1}{x \cdot \frac{1}{\tan(x)}}$$

Can I use program to find

$$\boxed{\lim_{x \rightarrow 0} f(x)}, \quad f(x) = \begin{cases} x^2 + 1 & \text{if } x > 0 \\ \sin(x) & \text{if } x \leq 0 \end{cases}$$

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Panel 9

Sophisticated example: Solve $f(x) = 0$, where f is continuous

i.e. solve $x^2 - 4 = 0$ $x = \pm 2$ ✓

solve $x^5 - 4x + 1 = 0$ $x = ???$ no clue!

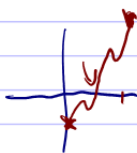
Ex: Show that $x^4 - 2x - 1 = 0$ has at least one solution in interval 0 to 2 .

Intermediate Value theorem:

$$f(0) = -1 < 0$$

$$f(2) = 11 > 0$$

by IVT there is a value s.t. $f(c) = 0$



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Panel 10

$$f(x) = x^4 - 2x - 1, \text{ on } (0, 2)$$

$$f(0) < 0, f(2) > 0 \quad \text{best guess: } x = 1 \text{ (middle)}$$

$$f(1) = -2 \neq 0 \quad \text{too bad.}$$

$$f(1) < 0, f(2) > 0 \quad \text{best guess: } x = 1.5 \text{ (middle)}$$

$$f(1.5) = 1.06 \neq 0 \quad \text{too bad}$$

$$f(1.5) > 0, f(1) < 0 \quad \text{best guess: } x = 1.25$$

$$f(1.25) = -1.05 \quad \text{best guess: } \frac{1.25 + 1.5}{2} = \text{middle}$$

Keep going next time!

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